Town of Hampton

Received
8/16/2013
NWT

August 12, 2013

US Environmental Protection Agency
5 Post Office Square – Suite 100
Mail Code –OEPO6-4
Boston, Massachusetts 02109-3912
Attn: Mr. Newton Tedder

Ref: MS4 Draft Permit Comments

Dear Mr. Tedder:

The Town of Hampton would like the Environmental Protection Agency to consider the following comments concerning the 2013 Draft MS4 Stormwater Permit. Our comments follow the order of the items in your Draft Permit to aid you and others in the review of our comments.

The Town is also part of a MS4 Coalition. Accordingly, additional comments will be submitted on behalf of the Town of Hampton from Sheehan, Phinney, Bass + Green, PA.

1.9.1 Certify Eligibility with regard to Federal Endangered and Threatened Species and Critical Habitat Protection.

The Town is neither prepared nor qualified to certify its own compliance with endangered/threatened species and /or critical habitat regulations. This type of certification requires educated and trained people to do the work. Furthermore, we are of the opinion that the responsibility of ensuring that permit requirements do not conflict with the Endangered Species Act (ESA) rests solely with the EPA. The Town cannot relieve the EPA of its responsibility under the ESA by having it included within this draft permit. We herewith request that you remove it from the permit.

100 Winnacunnet Road, Hampton, New Hampshire 03842 Tel. 603-926-6766 Fax 603-926-6853

Waiver Granted to Hampton Falls

We note for the record that the EPA granted the Town of Hampton Falls a waiver from the MS4 requirements on April 30, 2013. The Taylor River begins in Hampton Falls and flows along our common town boundary until the river becomes the Hampton and Seabrook common line. It appears from our review of the 2010 TMDL Report prepared by the State that the two (2) locations tested on the Taylor River are as follows.

> NHEST600031003-02 where the Taylor River passes under NH Route 1
>
> NHEST600031003-03 just southeast of where the river passed under the former Boston & Maine railroad trestle. The former rail bed is now owned by the State of NH Department of Transportation.

Our point is that both of these locations are strongly influenced by the land that lies within the Hampton Falls boundary. We expect to take additional water samples further up the river to determine what effect, if any, the flow from other areas has on these locations.

2.2.1.e Hampton is listed as a Town with a TMDL for bacteria.

The Town is listed as having waters in our community impaired by bacteria in Attachment F of the Draft permit. It is our understanding that this requirement is based upon the 2010 TMDL study and report that the NHDES submitted to your office. Since the drafting of the permit the State has issued the 2012 TMDL study in its final format and as a result Hampton is no longer listed as having water bodies impaired due to bacteria. We also take issue with how Hampton was listed in 2010 and the benchmark for that TMDL. The State of NH Department of Environmental Services used a very small data set to determine what the State wide limit for bacteria should be. We feel that the State should collect more samples from around the state to determine the TMDL. If the State had known that a whole Federal program was going to be based on the data in the TMDL they may have taken the time to collect many samples over several years.

At this time we request that Hampton be dropped from having to test for bacteria because the State 2012 TMDL listing no longer shows our water bodies impaired for bacteria. A second reason for dropping this requirement as to Hampton is that the headwaters of the Taylor River lie totally within the Town of Hampton Falls, which has been granted a waiver from your office. The issue is further complicated in that the Taylor River is the boundary between three (3) Towns. Any efforts to clean boundary waters would require the Towns of Seabrook, Hampton Falls and Hampton to develop rules and ordinances to address any response.

Appendix F of the 2013 Draft MS4 Permit (73 pp.)

We would like to call your attention to page 4 of this attachment. In section 1 on this page it is stated that "Water Quality Goal of TMDL" is " a geometric mean for fecal coliform of less than 14 MPN/100 milliliters and a 90th percentile of less than 43 MPN/ 100 milliliters as determined using National Shellfish Program (NSSP) protocols". (MPN = Most Probable Number).

In comparison, the 2010 Consolidated Assessment and Listing Methodology (CALM) report prepared by the State and adopted by the EPA states that the limits for Enterococcus is a geometric mean of 35 cts\ 100 mill-liters and a single sample maximum of 104 cts\ 100 mill-liters.

There appears to be a difference in these standards and we would like to know which standard controls. If we are forced to meet the NSSP limits this may not be possible because we do not control all of the land draining into the Taylor River and its headwaters.

Taylor River Watershed Issues

The Town is very familiar with the water quality of the Taylor River and potential causes of pollution and contamination in the watershed. Since 2006 the Town has been working with the State Department of Transportation on removal of a dam on the north side of Interstate 95. At issue is the 77,000 cu. yds. of silt behind the dam and the chemicals held within this silt, such as the pesticide DDT and its breakdown products, DDE and DDD. Please refer to the attached external memorandum prepared by ExPonent dated December 10, 2009. The second issue is that the pond held behind the dam has a low oxygen count at its lower depths. While we have not specifically tested this water body for bacteria we assume that what is occurring in this section of the river has a direct impact upon the bacteria results the State DES obtained and reported in the 2010 TMDL listing.

We also suspect that along with the DDT that possibly came from the apple orchards in the abutting community that bacteria also comes into the water body because that community does not have a municipal sewer system. It is possible that older failing septic systems in the land area along the upper tributary of the Taylor River contribute to the bacteria. Without further testing and analysis the effect of the residential development along the river cannot be determined with any certainty.

As you can see the issues and our concern for the Taylor River go far beyond bacteria in the lower section of the river. We request that you allow the Town the time to work out a solution for this dam with the State Departments of Transportation, Environmental Services, Dam Bureau, Fish and Game and US Coast Guard. These issues are complex and take time.

Designated Uses as Listed in Appendix F of the 2013 Draft MS4 Permit – Table F-1

We noted in this table five (5) locations of testing with three (3) of these exceeding the single sample limit for fecal coliform and therefore requiring the development of a better management practices (BMP) to achieve [fecal] bacteria reductions. What we would like to call to your attention is the designated use label applied to the Hampton River Marina SZ which is currently listed as a primary contact recreation (PCR) based on the assessment that it is used for swimming. In our opinion the marina's primary use is for boating and therefore should be listed as a secondary contact recreation SCR (boating).

This is important at this time because the designation will determine the type of bacteria we need to test for and the allowable limits in the future. Our second reason for pointing this out is that the stated goal on page 4 of appendix F is "to remove all human sources of bacteria to the estuary to the extent practicable".

At this time we request that we be dropped from having to test for bacteria because the State 2012 TMDL listing no longer shows our water bodies impaired for bacteria.

2.3.4.8.d Outfall & Interconnection Screening and Sampling

The Town of Hampton is a seaside community that is strongly influenced and controlled by the weather. In recent years the residents of the Town have experienced more frequent flooding in many areas of the Town. Several of our drainage systems have drainage gates on the end of them to prevent seawater from entering the drainage systems during high tides. When a rain or snow event occurs during a high tide the low lying areas flood because the high tide will not permit the tide gates to open. In many cases the flooding is only partially alleviated in the short time period between high tides.

When this occurs the water in the pipes and catch basins will be contained anywhere from 24 hours to several days. We suspect that during this time period the bacteria in the drainage system grow to exceed TDML limits. This means that we may never achieve a low acceptable bacteria count in the tidal controlled drainage systems.

Therefore, we would propose that the Town, working in concert with the State, be permitted to collect multiple samples over a two (2) year period from the tide gate controlled systems. This would allow us to determine if bacteria in these systems is an issue and to what level. We would also propose that the tide controlled structures are unique and that if we are required to test for bacteria that a separate TMDL be established. We also feel that this is an ongoing program and that the TMDL level should be revisited after three (3) more years and before the MS4 permit is renewed in the future.

Given the recent release of the 2012 TMDL's we would ask that no testing be required within this permit until such time as a proper set of TMDL's has been established.

2.3.4.9.c.i IDDE Program Implementation Goals and Milestones

This section states that 80% of all of our problem catchments need to be sampled and tested within three (3) years of the permit date and 100% within five (5) years. We have determined that all of our catchments fall into the problem designation because of a note in Appendix F, page 5. This note reads as follows. "Catchments draining to any waterbody with an approved bacteria TMDL shall be designated either Problem Catchments or HIGH priority in implementation of the IDDE program". The five (5) testing sites listed in table F-1 of Appendix F are listed as impaired for bacteria therefore all of our catchments are Problem Catchments. Given the recent release of the 2012 TMDL's we now request that no testing be required for bacteria and also that all of our catchments are no longer classified as Problem Catchments.

Our issue with this section of the draft permit is the time it will take to locate, catalog, install signs and test each one of our outfalls and catchments. Our first look at the number of outfalls we have is approximately 160. If we are to look at 80% of these within three (3) years and have to install signs ($100 each) and test each location ($100 to $150 each) it will cost the Town between $8500 to $10,500 per year plus labor. At the same time we are trying to install all of the outfall signs we are also trying to meet a 2017 deadline to have all street and traffic signs upgraded to meet the Federal DOT guidelines.

In discussions with the State and other members of our local Stormwater Coalition it is the collective opinion that the amount of work you are asking us to do should be spaced out over 10 to 20 years. This is due to the amount of funding it will take and the amount of time. We also feel that if the source of bacteria in the stormwater could be due to leaking sewage collection pipes (exfiltration). If this is the case then it may take more time than allowed under the permit to replace those older sewer pipes that may contribute to a non-point source of bacteria.

Waiver Request

The Town of Hampton herewith requests a waiver from the MS4 program as a whole because of the recent release of the 2012 TMDL listing. If a major reason for including the Town in this program was the basis that our waters were impaired, then the new TMDL listing excludes us. It is apparent to us in the community that the process of determining TMDL's and thus the need to the MS4 program is flawed and therefore should be scrapped.

The EPA and the State DES need to work together better to determine what is impaired water and what is just a historical background element. Case in point would be to determine what the background level for arsenic is when our whole State rests on bedrock containing arsenic. If we cannot agree on arsenic then the residents of our State and Town wonder if we really can differentiate between in bacteria levels caused by humans and those resulting from wildlife.

Summary

In summary it is our collective opinion that the scope of the draft permit is too wide and too aggressive. We do agree that the waters of the State need to be kept clean and that our physical health and economic well-being are directly tied to these waters. We here in Hampton are more sensitive to this than some of our neighbors because we see many people come to the beach and harbor each year to enjoy our shared resources. In the same respect, with this many people coming into the Town our ability to handle one more federal program is pushing us to the edge. We already sweep the sidewalk along the beach each day, maintain expensive vacuum and jetting trucks for cleaning basins and pipes and allocate staff to these tasks on a daily basis. This draft permit seeks to take stormwater management, cleaning and reporting to a whole new level that would burden the Town to the same extent as our efforts to manage wastewater.

We would appreciate being able to participate in a regional discussion that has stormwater being monitored, cleaned and reported based upon a watershed rather than a population density level from the census. Many agencies have reported that the increase in stormwater runoff is caused by the increase in impervious areas within each watershed. It would then be logical to determine which communities need to be included in the program by the percentage of impervious areas instead of population. The technology to accomplish this exists with the use of satellite imagery to determine water quality, crop growth, nesting bird densities and other data. In our opinion it was a flawed decision to determine which communities need to participate in the MS4 program based upon census data instead of a true indicator such as impervious areas. Currently FEMA is using better technology and data to produce new flood maps. They have used historical flood data, two (2) foot interval digital maps and improvements in analysis to achieve this. Provisions need to be made so that the rules under the permit can changes as the technology improves.

We also feel that it is an error to not have testing, analysis and remediation measures focused on the water body boundaries rather than using artificial, political boundary lines as a default. It would seem prudent to request that communities adjacent to a common water body have the same group of measures to more effectively deal with a problem and obtain an improvement. This would result in some communities having a smaller area in an MS4 and other communities not being released from the program without just cause.

We look forward to having you review our comments and work with us to write a permit that takes into consideration the challenges and needs of the residents of the Town of Hampton.

Please feel free to contact me at 926-3202 if you have any questions.

Sincerely,

Chris Jacobs

Chris Jacobs, PE
Deputy Director of Public Works

Frederick Welch
Hampton Town Manager

Enc. ExPonent memo dated December 10, 2009

Exponent

EXTERNAL MEMORANDUM

TO: E. Tupper Kinder, Esquire

FROM: Pravi Shrestha

Susan B. Kane Driscoll

CC: Charles Menzie

DATE: December 10, 2009

PROJECT: 0906488.000 02F1

SUBJECT: Preliminary Review of Sediment Management Plan

Introduction

As requested by E. Tupper Kinder, Esquire, on behalf of the Town of Hampton, NH, Exponent prepared this memorandum summarizing our preliminary review of *Appendix D: Taylor River – Sediment Management Plan* of the *Final Draft Feasibility Study* prepared by The Louis Berger Group in association with GEI Consultants (Louis Berger 2009). The Feasibility Study evaluated different alternatives for replacing or removing the Taylor Pond Dam, which is located in Hampton Falls and Hampton, New Hampshire. The Sediment Management Plan evaluated three alternatives in terms of management of the sediments that have accumulated behind Taylor River Pond Dam, with the intent of reducing the potential for impacts to the downstream environment and the ecosystem. This review represents the results of Exponent's preliminary review of the Sediment Management Plan. The three alternatives evaluated in the Feasibility Study were:

- Alternative A – No Action
- Alternative B – Remove the existing I-95 bridge, the existing spillway/fishway, and the existing emergency spillway, and replace with a new I-95 bridge and spillway/fishway
- Alternative C – Remove the existing I-95 bridge, existing spillway/fishway, and existing emergency spillway, and replace with a new I-95 bridge.

The scope of work calls for Exponent to evaluate the technical considerations and approaches inherent in the sediment management plan with the objective of 1) identifying any deficiencies in the various sediment management approaches with respect to mobilization and transport of sediments in the river, pond, and downstream waters, and 2) providing recommendations for additional analysis or evaluation, if required.

In the text that follows, reference is made to the Taylor River system, which includes the Rice Dam impoundment, Taylor River, Taylor River impoundment, and downstream of Taylor River impoundment.

The key findings of our review are summarized as follows:

- The spatial extent of sediment contamination and sediment toxicity in Taylor River Pond is not adequately characterized for purposes of delineating the area and volume of material to be dredged (excavated) indicated in Alternatives B and C of the sediment management plan.
- The U.S. Army Corps of Engineers' River Analysis System (HEC-RAS model) does not adequately characterize the velocities in the system for purposes of assessing sediment mobility and subsequent transport.
- The potential mobility of sediments in the Taylor River system is not adequately addressed in terms of a physics-based approach to incipient motion of sediment particles. Incipient motion (initiation of motion) refers to the condition when the bed sediment particles will begin to move, i.e., when the bed shear stress induced by flow exceeds that required to move the particles.
- No attempt was made to quantify sediment transport in the Taylor River system with respect to spatial and temporal distribution of sediments resulting from the combined action of freshwater and tidal flows for each of the three alternatives. As a result, the potential impacts on the aquatic environment and ecosystem could not be addressed.

Based on our review, it is recommended that a numerical model of hydrodynamics and sediment transport be developed for the Taylor River system, to quantify sediment transport in the system resulting from implementation of the three alternatives.

Background

The Taylor River Pond is an approximately 47.5-acre impoundment created by an earthen embankment located at the crossing of Taylor River and Interstate 95 (I-95). The total watershed area upstream of the dam is about 7,075 acres. Tributaries to Taylor River include Grapevine Run, Clay Brook, Old River, and Ash Brook. Taylor River flows out of the pond through a primary spillway structure. A fishway installed on the primary spillway provides for fish passage. Excess flows in the Taylor River are discharged downstream under the I-95 bridge through a sheet pile emergency spillway and associated pipe-arch culvert. The dam currently delineates the upstream limit of tidal influence.

Construction of the dam resulted in accumulation of organic-rich fine-grained sediments in the impoundment. The volume of accumulated sediments was estimated by Louis Berger (2009) to be 77,000 yd^3. Chemicals associated with the sediments exceed certain screening-level sediment guidelines for both fresh water and marine waters. Chemicals of particular concern include the pesticide DDT, and its breakdown products, DDE and DDD. Because the sediments exceed screening-level guidelines, the potential for adverse impacts to sediment-dwelling invertebrates cannot be ruled out and sediment toxicity tests were conducted. Two of the three sediment samples tested showed significant toxicity in comparison to a laboratory control: one sample collected from the lower section of the Taylor River Pond near the primary spillway (sample location TR-S6) and one sample at an upstream location near the Rice Dam impoundment (sample location TR-S11).

As part of the feasibility study performed by Louis Berger (2009), a sediment management plan was prepared to address sediment management measures to reduce the potential mobilization and transport of contaminated sediments from the pond to downstream waters resulting from implementation of three alternatives for replacing the I-95 bridge, and removing or replacing the primary spillway, fishway, and emergency spillway/culvert. Descriptions of the three alternatives, with respect to the sediment management plan, are provided below. Louis Berger (2009) indicates that the sediment management plan would need to be refined upon selection of a preferred alternative.

- **Alternative A: No action**—This alternative is intended to serve as the base case for comparison with the other alternatives. The accumulation of sediments in the pond and their potential transport downstream would be representative of existing conditions. If the dam breached and/or the spillways failed, sediments in the pond could be mobilized and transported downstream.

- **Alternative B: Replacement of I-95 bridge and new spillway/fishway**—In this alternative, the existing I-95 bridge, primary spillway, and emergency spillway/culvert would be removed. This would be replaced with a new 70-ft long (abutment-to-abutment) concrete bridge, a 50-ft wide spillway, and a new Denil fishway. For this alternative, the sediment management plan recommends removal of approximately 1,200 yd^3 of sediment (including a 35 percent overexcavation) from a small area in front of the proposed bridge location on the upstream side. The excavation area is 16,000 ft^2 and the depth of excavation is 1.5 ft. The removed sediment would be disposed of offsite.

- **Alternative C: I-95 bridge replacement without spillway**—In this alternative, the existing I-95 bridge, primary spillway, and emergency spillway/culvert would be removed. This would be replaced with a new concrete bridge similar to the one discussed in Alternative B. There would be no provision of a spillway/fishway. For this alternative, the sediment management plan recommends removal of approximately 7,000 yd^3 of sediment (including a 25 percent overexcavation). The excavation area is 100,000 ft^2 and the depth of excavation is 1.5 ft. Removed sediment would be disposed of offsite. The sediment management plan also includes measures to stabilize the exposed tidal marsh, specifically along the edges of the tidal creek to reduce sediment erosion at these locations.

Potential Issues with Proposed Sediment Management Plan

Based on our current understanding of the sediment management plan, we have identified a number of issues that need to be addressed with regard to the mobilization and subsequent transport of contaminated sediments from Rice Dam impoundment, Taylor River, Taylor River impoundment, and downstream of Taylor River impoundment (hereinafter referred to as the Taylor River system).

The spatial extent of sediment contamination in Taylor River Pond is not adequately characterized. The sediment management plan for Alternatives B and C assumes that only a small volume of sediments (approximately 1,200 yd^3 for Alternative B and 7,000 yd^3 for Alternative C) would be dredged in the vicinity of the location where the new primary spillway structure would be constructed for Alternative B. This represents about 1.6 percent (Alternative B) and 9.1 percent (Alternative C) of the total volume (77,000 yd^3) of sediments accumulated in the impoundment since the construction of Taylor Pond Dam. The sediment quality sampling results in Table 8 of the feasibility study show that the contaminant concentrations in sediments just upstream of the primary spillway (TR-S5) are relatively higher than further upstream or downstream. However, contaminant concentrations at upstream locations are also higher than downstream of the impoundment (TR-S4) for some of the contaminants. As noted above, two sediment samples tested showed significant toxicity: one sample collected from the lower section of the Taylor River Pond near the primary spillway (sample location TR-S6) and one sample at an upstream location near the Rice Dam impoundment (sample location TR-S11). Therefore, potential migration of sediment and associated contaminants from these areas to downstream locations could result in an increase in concentration in the downstream sediment. Sediment-associated contaminants were assessed at only a limited number of sampling locations. There were four sampling locations upstream of the I-95 bridge location and one sampling location downstream. It is not clear what the justification was to dredge (excavate) only a limited area and corresponding volume of sediment for each of the two Alternatives B and C. Additional sampling efforts would provide a more detailed spatial distribution of the concentration of contaminants in the bed sediments that would serve to guide the selection of the area and volume of dredging (excavation).

The U.S. Army Corps of Engineers' River Analysis System (HEC-RAS model) does not adequately characterize the velocities in the system for purposes of assessing sediment mobility and subsequent transport. The feasibility study describes the application of the HEC-RAS model to simulate water surface elevations and velocities for Alternatives B and C. Approximately 6,900 ft of the Taylor River were modeled, encompassing about 6,500 ft upstream of the existing I-95 bridge and about 400 ft downstream of the bridge. The HEC-RAS model simulations represented the 2-, 10-, 50- and 100-year steady-state peak flows in the river. For Alternative B, 22 cross-sections and two bridges (i.e., the Towle Road bridge and proposed I-95 bridge) were modeled. The 100-year flow velocities at 11 of these cross-sections exceeded 1 ft per second (fps). This included an approximate 350-ft reach upstream of the proposed bridge location. For Alternative C, 21 cross-sections and two bridges (i.e., the Towle Road bridge and proposed I-95 bridge) were modeled. The 100-year flow velocities at 15 of these cross-sections exceeded 1 fps. Thus, for both alternatives, the velocities at many of the modeled sections upstream and downstream of the proposed I-95 bridge for the 100-year flow are sufficiently large to mobilize bed sediments in that area.

A number of issues with respect to the HEC-RAS model were identified, as follows:

- The HEC-RAS model is a one-dimensional model. The velocities derived from the model are representative of the average velocities at specific cross sections. The model does not represent the spatial variation across the section, and hence cannot be used to assess the mobility of bed sediments along a given transect.

- The HEC-RAS model for Alternative B appears to have been applied with the flow conveyance blocked up to the high monthly tide elevation of 7.21 ft at the new spillway. With this configuration, the velocity at each section upstream of the impoundment is representative of the average velocity in that section, whereas the velocity at each section downstream of the impoundment does not incorporate tidal velocities at that section. Thus, velocities from flooding and ebbing of the tide are not realistically reflected in the HEC-RAS model results at cross-sections downstream of the proposed I-95 bridge.

- The HEC-RAS model for Alternative C appears to have been applied with the flow conveyance blocked up to the high monthly tide elevation of 7.21 ft for the entire reach (i.e., upstream and downstream of the impoundment). With this configuration, the velocity at all cross-sections does not include the effect of tidal velocities, and hence are not representative of the system for making any inference with respect to sediment mobility.

The potential mobility of sediments in the Taylor River system is not adequately addressed in terms of a physics-based approach to incipient motion of sediment particles. As indicated in the feasibility study, the sediments in the Taylor River system are organic-rich fine-grained sediments contaminated with pesticides, metals, and PAHs. Table 6 of the feasibility study indicates fine-grained sediments in the silt-clay size range are greater than 20 percent, and the total organic carbon (TOC) concentrations are about 5 percent, 4–8 percent, and 1.5 percent, respectively, in Rice Dam impoundment, Taylor River pond, and downstream of Taylor River pond. The mobility of the sediments is a function of flow-induced bed shear stresses and a critical shear stress for incipient motion. As noted earlier, incipient motion (initiation of motion) refers to the condition when the bed sediment particles will begin to move, i.e., when the bed shear stress induced by flow exceeds that required to move the particles.

Exponent identified a number of issues with respect to sediment mobility, as follows:

- The spatial extent of sampling for grain size distribution measurements appears to be inadequate. As indicated in Table 6 of the feasibility study, only ten locations were sampled, two upstream of Taylor River pond, seven within the Taylor Pond dam impoundment, and two downstream of the impoundment. Additional grain size measurements would be useful to assess the type of sediments adjacent to the shoreline. This information would be important for any sediment transport study.
- The feasibility study does not address whether the sediments can be characterized as cohesive or noncohesive. This is important because the physical processes influencing their transport are different (see Appendix A for details).
- Critical shear stress for incipient motion was not addressed in the feasibility study. General statements regarding sediment mobility were made based on velocities obtained from the HEC-RAS model, but there is no realistic representation of the potential for sediment mobilization in the system.
- The feasibility study did not address the concept of flow-induced bed shear stresses as the driving mechanism to assess sediment mobility.

No attempt was made to quantify sediment transport in the Taylor River system. The feasibility study makes only generalized statements regarding potential sediment transport in the system. Specific examples include:

> (For Alternative B): velocities 200 ft upstream of the new spillway dam (Alternative B) during a 100-year storm are very low (0.5 ft/sec) which would not be sufficient to erode the sediment in the pond. As water is funneled toward the new spillway, velocities increase.
>
> (For Alternative C): Tidal flows would likely result in erosion of those parts of the former tidal creek channel that were excavated. It is reasonable to assume that, over time, the pre-dam channel would largely be scoured out naturally by tidal and freshwater flows.

Adequately characterizing the transport of sediments from the impoundment to downstream waters would require development of a numerical model for hydrodynamic and sediment transport. Freshwater flows during storm events (e.g., May 14–15, 2006, storm event) or the 100-year flow in Taylor River combined with tides would provide a realistic representation of flows in the system. The resulting flow velocities will serve as the driver for the sediment transport model.

- For Alternative A, the freshwater flows will influence sediment movement upstream of the impoundment resulting in sediment outflow over the existing primary and emergency spillway structures. The tidal flows are limited to the Taylor River and Estuary downstream of the spillway structures. Hence, tidal flows downstream of the impoundment will influence how these sediments are mixed and transported in the estuary.
- For Alternative B, the forcing functions for sediment mobilization and transport are similar to Alternative A, except that the volume of sediment outflow over the new spillway structure could increase, given the extended length of the spillway/fishway at the I-95 bridge opening. Tidal flows downstream of the impoundment will influence how these sediments are mixed and transported in the estuary.
- For Alternative C, both the freshwater inflows and the tidal flows will influence the sediment movement in the system. The combination of high freshwater flows with ebb tides will likely be the condition where maximum amounts of sediment are mobilized and transported out from the impoundment. The absence of any spillway structure at the new I-95 bridge crossing could scour out the sediments upstream of the impoundment. Sediments from the reaches downstream of the bridge location could also be transported and mixed with the pond sediments. Furthermore, the intrusion of saline water into the Taylor Pond impoundment will change the settling behavior of cohesive sediment flocs (aggregates) because saline water enhances flocculation (aggregation).

Recommendations

To realistically quantify sediment transport in the system resulting from implementation of the three alternatives, it is recommended that a two- or three-dimensional numerical model of hydrodynamics and sediment transport be developed for the Taylor River system. A multi-dimensional modeling framework is necessary to account for spatial variability of current velocities and sediments in the system. A brief description of the model, data requirements and availability, and proposed simulations for the three alternatives is provided below.

Hydrodynamic and Sediment Transport Numerical Model

The model will be composed of sub-models for hydrodynamics and sediment transport. The sub-models will be coupled together such that output from the hydrodynamic model will serve as input to the sediment transport model. The model domain will consist of Rice Pond impoundment, Taylor River Pond, and the downstream Taylor River Estuary. Data requirements for the hydrodynamic model will include current bathymetry, freshwater inflows, characterization of the bottom roughness, and tidal elevations at the downstream boundary. If winds are a factor in driving circulation, then meteorological data on wind speed and direction can be input to the model. Output from the hydrodynamic model will include the spatial and temporal distributions of water surface elevations, velocities, circulation patterns, and mixing. The hydrodynamic model would need to be calibrated to water surface elevations and velocity measurements at selected locations.

The results of the hydrodynamic model will serve as input to the sediment transport model. The sediment transport model can be set up to simulate either cohesive sediments or noncohesive sediments or both, depending upon the sediment characteristics at the site. Data requirements for the sediment transport model include sediment loading from freshwater inflows, sediment bed properties such as density, erodibility (if the sediments are cohesive), grain size distributions, and suspended sediment characteristics such as settling velocity. Output from the sediment transport model will include suspended sediment concentrations, mass of sediment eroded/deposited and subsequent changes in bed elevations throughout the model domain. The sediment transport model would need to be calibrated for total suspended sediment (TSS) concentrations at one or more selected locations.

Data Requirements and Availability

The following data will be required to support model development and application. It is anticipated that some of the data are already available with the New Hampshire Department of Environmental Services (NHDES), the New Hampshire Department of Transportation, and other agencies or local governments.

Hydrodynamics

- Bathymetric data for the Taylor River system including the Rice Dam impoundment, Taylor River, Taylor River impoundment, and Taylor River Estuary. Bathymetry survey data for Taylor River Pond gathered by HydroTerra from October 6 to 14, 2006, can be used as existing conditions bathymetry. The bathymetry of the Taylor River Estuary may be available from National Oceanic and Atmospheric Administration (NOAA).

- Freshwater flows as a function of time in the Taylor River and tributaries (e.g., Grapevine Run, Clay Brook, Old River, and Ash Brook) can be estimated from hydrologic modeling or from drainage-area proration of gauged flows. The highest flows in the system are likely to mobilize the maximum sediment, thus estimates of the May 14–15, 2006, storm event or the 100-year flows would likely represent the worst-case scenario.

- Tidal elevations at the downstream boundary of the model can be obtained from NOAA records of tides at Hampton Harbor. Additional tide elevations at another location will provide data for calibrating the hydrodynamic model.
- Meteorological data (wind speed and direction) can be obtained from NOAA and/or from nearby airports.
- Bottom roughness is a calibration parameter used in the hydrodynamic model. It is anticipated that this parameter will be varied to account for marsh vegetation and the presence of coarse-grained sediments.

Sediment Transport

- Sediment loading (i.e., TSS concentrations) in the freshwater inflows can be estimated from nearby United States Geological Survey (USGS) gauged watersheds.
- Sediment bed properties such as density and grain size distributions can be obtained from field sampling efforts performed by Louis Berger (2009). It is anticipated that these data will be supplemented by additional available data or from future sampling programs so that the Taylor River system is adequately represented. The grain size distribution data will be used to characterize the bed sediments in the Taylor River system as cohesive or noncohesive. Based on our review of the limited grain size distribution data described in the feasibility study, it appears that the model can be setup as a cohesive sediment model.
- The settling velocity and bed sediment erodibility are key parameters influencing cohesive sediment transport. Laboratory and field experiments can be carried out to determine whether these parameters or literature values can be used. In either case, simulations should include a sensitivity analysis of these parameters to develop confidence in the model.
- TSS data at selected locations in the Taylor River system will be used to calibrate the sediment transport model.

Modeling to Support Evaluation of Alternatives

Model simulations to evaluate each of the three alternatives are described below.

Evaluation of Alternative A

The model domain for Alternative A will consist of two segments – one upstream of Taylor Pond dam and one downstream in the Taylor River Estuary. The existing primary spillway/fishway and emergency spillway/culvert will be assumed to be in place. The model will be first applied to the upstream segment. Model results of sediment inflow over the spillway structures will serve as input to the downstream segment model. Various freshwater inflow scenarios can be simulated (e.g., hydrograph of the 100-year flow; hydrograph of the May 14–15, 2006, storm event). Downstream boundary conditions to the model will be represented by actual tidal elevations. The results of this evaluation will serve as the base case conditions that can be compared to results from Alternatives B and C. In addition, this model could also be used to simulate the failure of the existing spillway structures. The resulting sediment deposition/erosion and bed elevation changes will be compared to the base case.

Evaluation of Alternative B

The model domain for Alternative B will consist of two segments, similar to Alternative A. The new bridge opening and new spillway/fishway will be assumed to be in place. Model simulations will be performed with the same boundary conditions and model parameters as described for Alternative A. Two scenarios are anticipated: 1) conditions that reflect bathymetric changes as a result of proposed construction of the new I-95 bridge and new spillway/fishway, and 2) conditions that reflect bed profile changes resulting from dredging (excavation) upstream of the impoundment as described in the sediment management plan for Alternative B. The second scenario can be fine-tuned with respect to the area and volume of excavation based on the results of the first scenario. The results of the above simulations will be compared to those from Alternative A to assess the change in sediment distribution patterns and the total mass of sediment transported from the impoundment to downstream waters.

Evaluation of Alternative C

The model domain for Alternative C will consist of one complete segment, because the tides are assumed to move into and out of the impoundment. Model simulations will be performed with the same boundary conditions and model parameters as described for Alternative A. Two scenarios are anticipated: 1) conditions that reflect bathymetric changes as a result of proposed construction of the new I-95 bridge, and 2) conditions that reflect bed profile changes resulting from dredging (excavation) upstream of the impoundment as described in the sediment management plan for Alternative C. The second scenario can be fine-tuned with respect to the area and volume of excavation based on the results of the first scenario. The results of the above simulations will be compared to those from Alternatives A and B to assess the change in sediment distribution patterns and the total mass of sediment transported from the impoundment to downstream waters.

Evaluation of the above alternatives should include a sensitivity analysis of the key model parameters such as the bottom roughness, and parameters for settling velocity and bed sediment erodibility. Once a model is developed and calibrated, the model can be used to evaluate other alternatives, as needed.

References

Louis Berger. 2009. Final draft feasibility study (13408B) Interstate 95 bridge over the Taylor River Pond Dam (NHDES No. 106.08/.09), Hampton Falls, Hampton, NH. Prepared for New Hampshire Department of Transportation, Concord, NH. The Louis Berger Group, Inc., Manchester, NH, in association with GEI Consultants, Inc., Woburn, MA.

Appendix A
Sediment Transport Dynamics

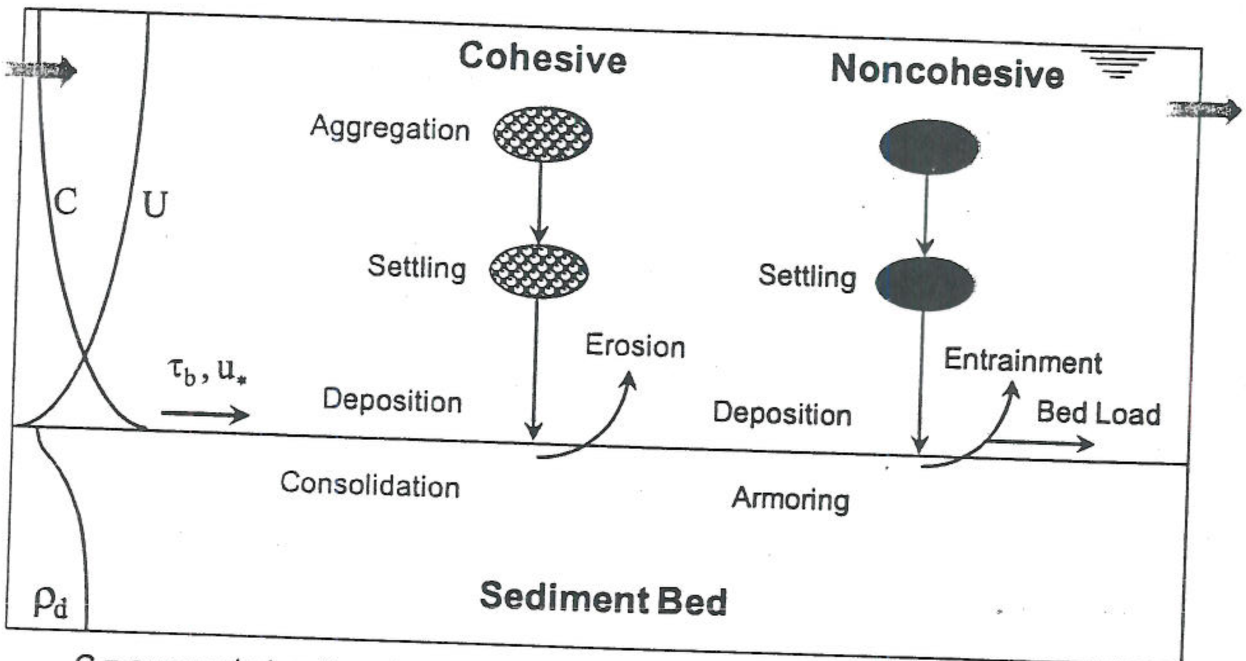
A synopsis of sediment transport dynamics for cohesive and noncohesive sediments appears below.

Figure A-1 shows a schematic of the processes influencing sediment transport. Sediments can be cohesive or noncohesive. Cohesive sediments consist primarily of clay-sized (< 2 μm) and silt-sized (< 75 μm) particles, mixed with organic matter, and sometimes, quantities of very fine sand. Noncohesive sediments are primarily sand-and gravel-sized material (> 75 μm).

The principal processes influencing cohesive sediments are advection, dispersion, aggregation, settling, deposition, consolidation, and resuspension. Aggregation is a function of cohesion and collision. Cohesion is the predominance of attractive forces over repulsive forces such that particles in close proximity can bind together to form flocs (aggregates). Collision of cohesive sediments is caused by Brownian motion, internal shear, and differential settling. Sediments settle through the water column and approach the bed. The deposition of cohesive sediments is a function of the settling velocity, the sediment concentration, and a probability of deposition. The settling velocity is a function of the concentration and the internal shear rate. The settling velocity, therefore, implicitly accounts for the mechanism of aggregation. The probability of deposition implies that sediments approaching the bed may or may not stick to the bed and reflects, in an implicit way, the effect of turbulence near the bed. Once sediments deposit to the bed, they consolidate such that the dry density increases with depth of sediment. If the shear stress caused by the flow is greater than the critical shear stress for resuspension, sediments are entrained into the water column. With depth, because of the increase in strength, the resuspension decreases. Sediment resuspension depends upon the bed shear stress induced by the flow and the resistance of the bed to erosion. Resistance to erosion depends upon the sediment type and mineralogy, pore and eroding fluid concentrations, the time history of deposition (i.e., whether the sediments are recently deposited, partially consolidated, or part of a more dense bed), and chemical and biological processes.

For noncohesive sediments, particles settle discreetly with settling velocities that depend upon the grain size. Deposition of noncohesive sediments is based on the settling velocity and the near-bed concentration. After depositing to the bed, particles may be transported in suspension or as bed-load, depending upon the relationship between the bed shear velocity, the critical shear velocity for incipient motion, and the settling velocity. If the bed shear velocity is greater than both the critical shear velocity for incipient motion and the settling velocity, particles are entrained into the water column and transported as suspended load. The maximum volume of particles entrained in the water column is based on the carrying capacity of the flow. If the bed shear velocity is greater than the critical shear velocity for incipient motion, but less than the settling velocity, particles are transported as bed load. If the bed material is heterogeneous, then the finer particle fractions are likely to be entrained first, leaving behind a surface layer of coarser particles that are less susceptible to entrainment. The coarser particle surface layer can also create an "armoring" effect, where some of the fine grained material is hidden from exposure to the flow. Both these mechanisms would result in armoring of the bed and entrainment would be inhibited. Armored parts of the bed can be disrupted during high flows.

When there are wind-waves, it is necessary to account for the shear stress caused by wave-current interaction, which is a function of the bottom orbital amplitude and bottom orbital currents, both of which are dependent upon the wave climate. Including the effect of waves is necessary, because the bottom shear stresses are an order of magnitude greater than stresses caused by currents alone.



C = suspended sediment concentration profile
U = velocity profile
τ_b = bed shear stress
u_* = bed shear velocity
ρ_d = bed sediment density profile

Figure A-1. Schematic of the processes influencing sediment transport